Space Weather Technical Forecast

Issued on Tuesday, 22 February 2022 at 13:02 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance throughout of M-class flares. Increasing Chance of Active fluence levels, mainly from day 3 (24 Feb) onward.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with one long duration C3.1 flare peaking at 21/1900 UTC from new Active Region 2955. There are currently three sunspot regions on the Earth-facing disc. AR2953 has shown some growth in its intermediate spots and areal extent, with a rudimentary penumbra in its leading spot. AR2954 in the NE appears to be a mature but stable Hsx/Alpha region. To the SE of this region AR2955 has emerged, which is also classified as a Hsx/Alpha. This region will need further analysis as it comes increasingly into view, as it is thought that this is the returning EX2938, which was the likely source of a notable far-sided flare and CME on the 15th Feb and, as stated above, has already produced a C class flare.

No Earth-directed CMEs were observed in the available imagery during the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, has indicated that Earth has been connected to the High Speed Stream (HSS) from a positive coronal hole, CH56/+. The wind speed has been slightly elevated or elevated, mainly between 495 and 590 km/s.The density has been average or slightly above average, up to around 14 ppcc at times. The total magnetic field strength (IMF) Bt, has been weak (<8 nT), with the Bz fluctuating between -7nT and +6nT. The phi angle has been mostly positive (away from the Sun) throughout. Resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3) with Active (Kp4) intervals between 21/1200-1500 UTC and 22/0300-0900 UTC respectively.

Energetic Particles / Solar Radiation: The high energy proton flux (10MeV) measured at GOES 16 remains at slightly above background levels. The high energy electron flux (greater than 2MeV) has been at background levels. The corresponding 24-hour integrated electron fluence is steady and well below the Active (1e8 integrated pfu) threshold. The 22/0001 UTC observation was 3.64e6 pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low, but there is a slight chance of rising to Moderate levels through the 4 days due to the potential for flaring from the two regions emerging from the northeast limb. The other sunspot regions on the Earth-facing disc are currently unlikely to produce significant flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in the forecast. Earth is experiencing a high speed stream from CH56/+, with this expected to persist during days 1 and 2 (22-23 Feb), before gradually easing. Geomagnetic activity is expected to start Quiet to Unsettled, with a chance of Active intervals and slight chance of a G1/Minor Storm days 1 (22 Feb). However, this risk will reduce through the forecast period and activity is expected to

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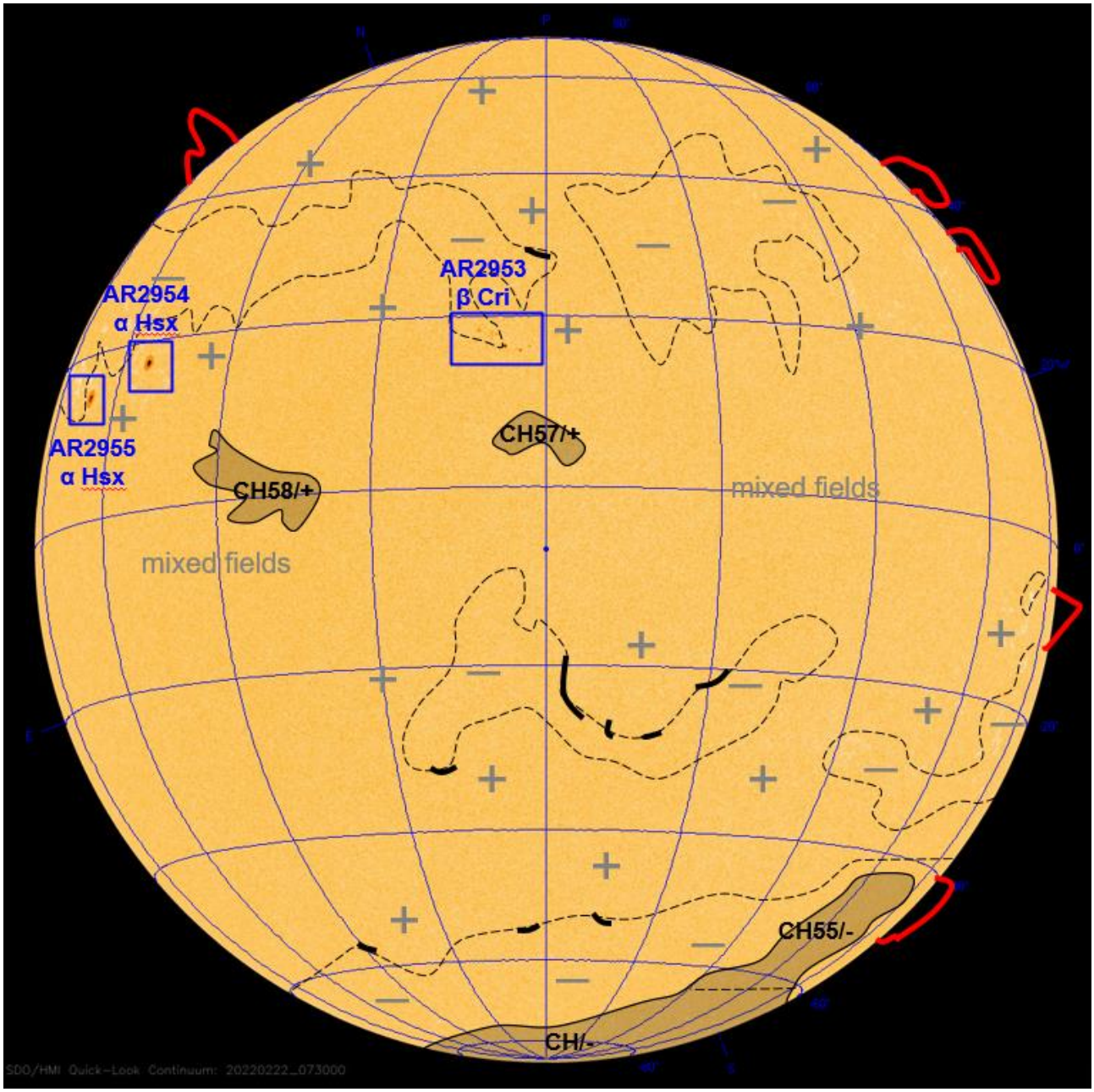
become predominantly Quiet for days 2 to 4 (23-25 Feb).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to fall to background levels and then persist at this level. The high energy (greater than 2 Mev) electron flux is currently at background, but may increase from day 1 (22nd) onwards, becoming Moderate with a chance of peaking at High (greater than 1000 pfu) levels around the diurnal maximum. The associated fluence is also likely to rise, with a chance of exceeding the Active threshold (1e8 integrated pfu), most likely on day 3 or 4 (24-25 Feb).

Figure 1. Solar Analysis Valid 22/0730 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs in the forecast, although there is a slight chance of weak CME effects on days 2 or 3 (23rd/24th) from a glancing blow from a filament lift off that occurred on the 19th Feb (Low confidence).

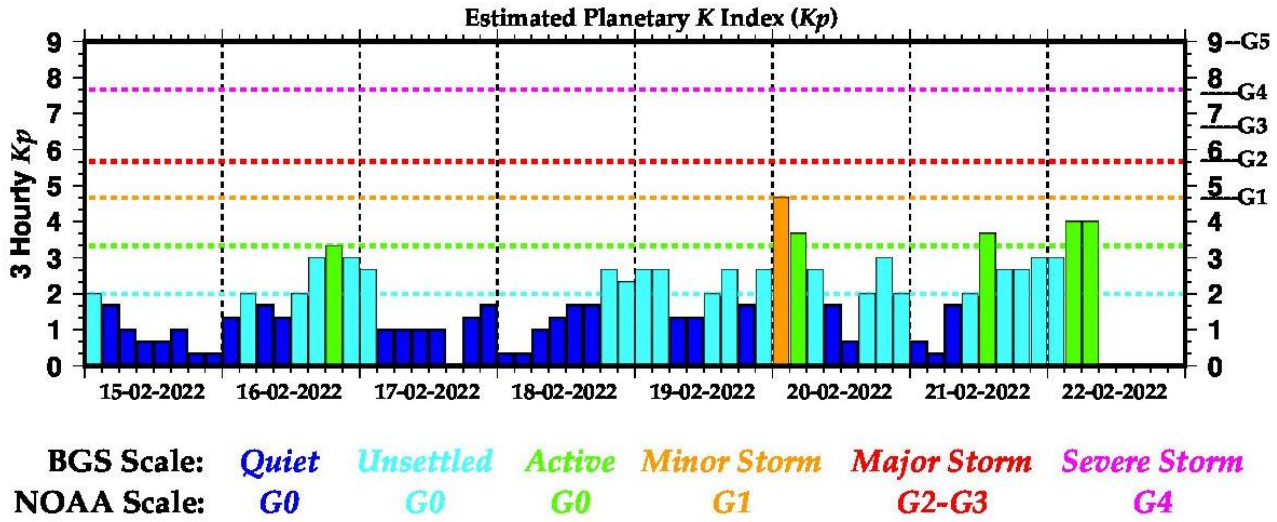
Solar wind speeds are currently elevated, due to the high speed stream from CH56/+. They are expected to remain elevated during days 1 and 2 (22-23 Feb), before gradually declining towards ambient levels through the remainder of the period as the effects of the coronal hole wane. Geomagnetic activity is expected to start Quiet to Unsettled, with a chance of Active intervals and slight chance of a G1/Minor Storm. However, this risk will reduce through the forecast period and activity is expected to become predominantly Quiet from day 2 (23 Feb).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	2	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: Estimated Plantary K Index (Kp) from BGS



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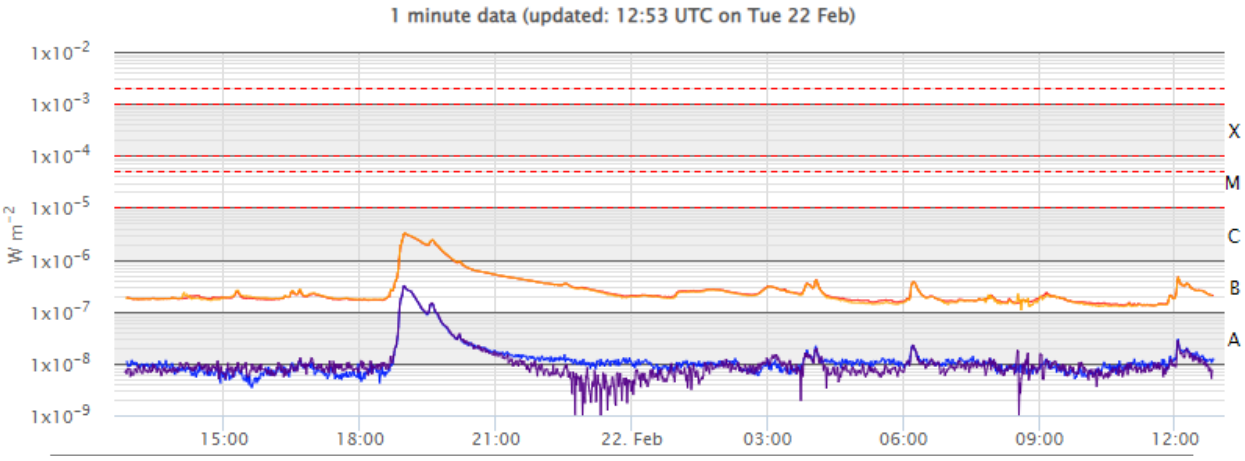
Radio Blackouts - X-Ray Flares:

There are currently three sunspot groups on the visible disc. Over the past 24 hours two regions have rotated round the northeast limb. AR2954 appears to be a mature but stable Hsx/Alpha region. AR2955 to the SE was the region that is thought to have been the source of an energetic flare and CME on the far side on the 15th. It has already produced a long duration C3.1 flare peaking at 21/2100 UTC, this region is currently also classified as a Hsx/Alpha region. AR2953, classified as a Cri/Beta region has shown some growth in its intermediate spots and areal extent, but remains stable and inactive.

Solar activity has been Low over the past 24 hours with just the one C flare mentioned above. It is likely to remain Low through the forecast period but there is a slight chance of it increasing to Moderate, with M-class flares, as the new regions rotates further onto the visible disc.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	15	20	20	20
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: GOES-16 X-Ray flares



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels since 18/1200UTC. The enhanced activity was due to a very large and energetic flare and CME seen on coronagraph imagery from the rearward eastern solar hemisphere on the 15th. This region has now rotated onto the visible disc and has been numbered AR2955, and produced a C3.1 flare around 21/1900UTC. Furthermore, energetic protons are largely guided along the Parker spiral, and consequently radiation storms are notably less likely from the eastern limb for all except the largest flares. Until we can fully assess an ongoing flare risk from this region, the chance of proton storms (S1, which is greater than 10pfu) is maintained at background.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO is currently at background, having dropped out on the 19th. With solar winds rising to elevated levels due to CH56, renewed electron charging is certainly possible. Electron flux may rise in the coming days, perhaps peaking at High levels (greater than 1000 pfu) from day 2 (23rd Feb) onward. On Days 3 and 4 (24-25 Feb), more persistently Moderate to potentially High flux is possible.

The associated 24 hour Fluence is currently well below the Active threshold and on a slight rising trend. In response to the weakening of the solar wind and the recent charging event, there is a gradually increasing chance of Fluence levels becoming Active (>1e8 integrated pfu). REFM is showing an overall rising trend in electron fluence over the coming days and can be used as a rough guide for likely fluence values.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	30	40	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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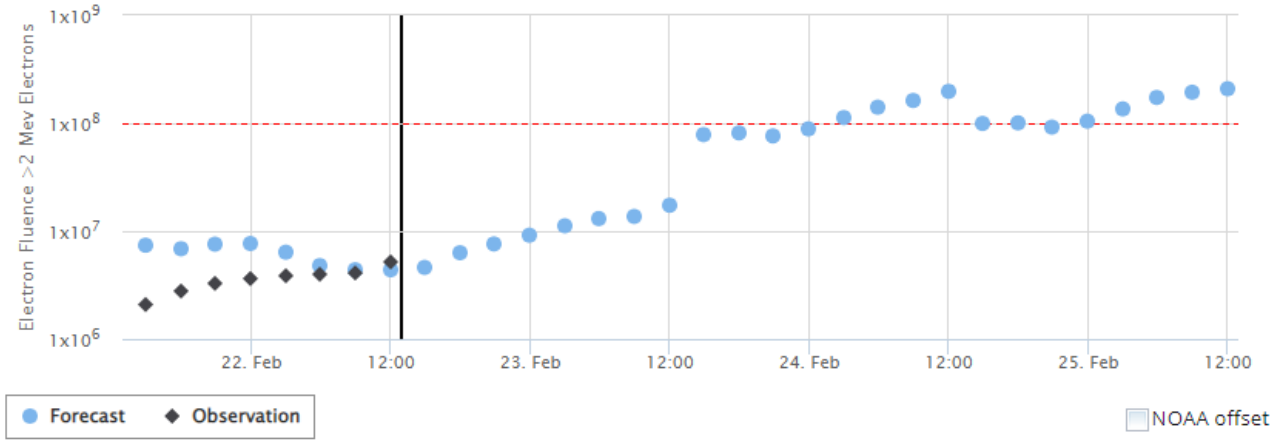
Figure 4: REFM electron fluence observations and forecast.



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